IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Wang, et al.
Appl. No.	:	09/929,821
Filed	:	August 14, 2001
For	:	HIGH STRENGTH ASYMMETRIC CELLULOSIC MEMBRANE
Examiner	:	Menon, K. S.
Group Art Unit	:	1723

DECLARATION OF I-FAN WANG

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, I-fan Wang, declare as follows:

1. I am a co-inventor of the subject application. I have a Ph.D. in membrane science and 21 years of experience working in research and development on membranes. During the last 10 years I have worked for the Pall Corporation (and/or its predecessor companies) and have studied and synthesized many different kinds of membranes.

2. I have reviewed U.S. Patent No. 6,045,899 issued to Wang, et al. ("the '899 patent"), of which I am a co-inventor. The '899 patent discloses highly asymmetric microfiltration membranes. The membranes are prepared from a relatively hydrophobic polymer, such as a polysulfone. Polysulfone membranes prepared according to the teachings of the '899 patent are substantially free of macrovoids, which are voids that materially vary in size from the surrounding porosity.

3. In the "Background of the Invention" section of the '899 patent, it states that "asymmetric membranes can be prepared from certain hydrophobic polymers, such as sulfone polymers and mixed cellulose esters." The teachings of the '899 patent, however, are directed to the preparation of membranes that are substantially free of macrovoids from hydrophobic

polymers, such as sulfone polymers, and not from hydrophilic polymers, such as cellulosic polymers. When cellulosic membranes are prepared according to the teachings of the '899 patent, the membranes contain macrovoids.

4. A scanning electron micrograph of a cross section of a cellulose acetate membrane prepared according to the '899 patent is provided as Figure 1. This membrane is prepared according to Example 1 of the '899 patent, but with cellulose acetate substituted for the polysulfone polymer (9% cellulose acetate comprising a 1:1 mixture of cellulose acetate CA 394 (acetyl content of 39.5, viscosity of 228 P, from Eastman Chemical Company) and cellulose acetate CA 398 (acetyl content of 39.7, viscosity of 114 P, from Eastman Chemical Company); 19% polyethylene glycol (MW 200); 4.3% polyvinylpyrrolidone; 1.8% water; and 65.9% N-methylpyrrolidone). As depicted in the cross section, the body of the membrane contains numerous macrovoids which break up the continuity of the membrane from the face with larger pores to the face with smaller pores. Such discontinuity inhibits the ability of the membrane to filter out increasingly smaller particles from a fluid as the fluid passes from the face with larger pores to the face with smaller pores.

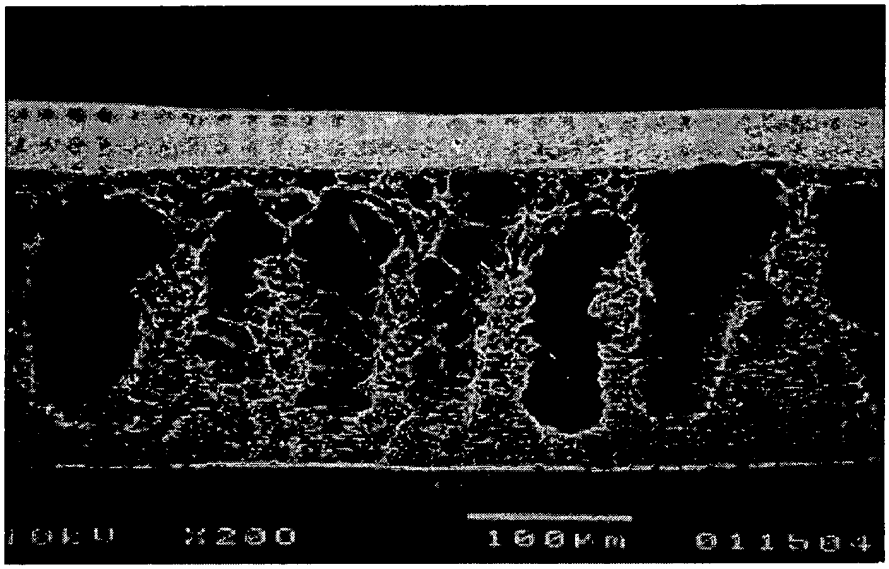

Figure 1.

5. Figure 2 is a scanning electron micrograph depicting a cross section of a cellulosic membrane of the present invention. In contrast to the membrane prepared according to the teachings of the '899 patent, the membrane of the present invention exhibits a continuous pore size gradient from the face with larger pores to the face with smaller pores. This structure allows the membrane of the present invention to outperform a cellulosic membrane made according to

the teachings of the '899 patent in some applications. Specifically, the membrane serves to filter increasingly smaller particulate impurities from a fluid passing through the membrane.

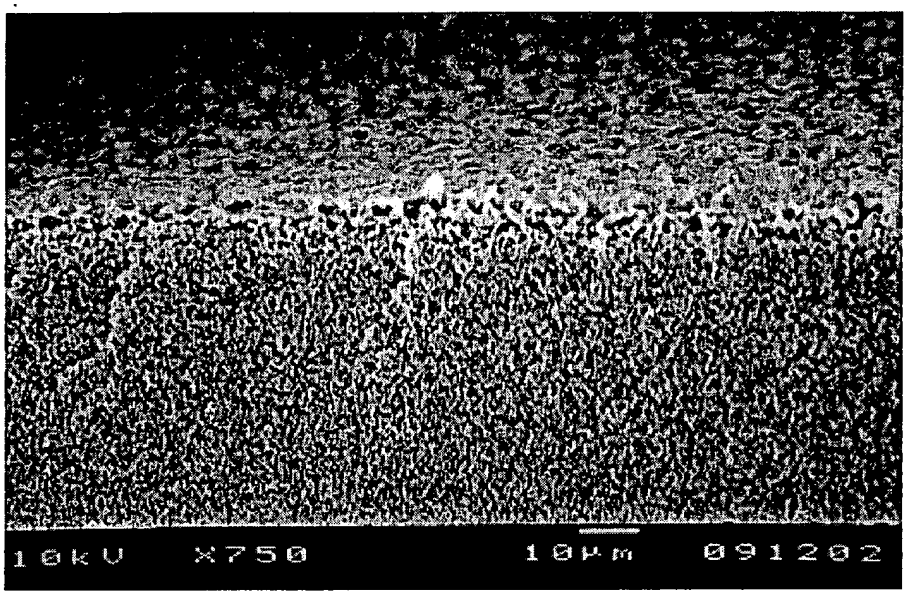

Figure 2.

6. The structure of the membrane of the present invention is attributable in part to the use of particular solvent systems which are not taught in the '899 patent. Compared to polysulfone, cellulose acetate is much more hydrophilic and solidifies much more slowly. In order to achieve membranes that are substantially free of macrovoids from hydrophilic polymers such as cellulose acetate, my co-inventor and I discovered that a low viscosity polar cosolvent of reduced volatility, such as methanol, can be employed. The solvent systems taught in the '899 patent are not suitable for use in preparing membranes that are substantially free of macrovoids from cellulosic polymers.

7. Accordingly, the structure of the membranes of the present invention embodies numerous advantages over cellulosic membranes prepare according to the teachings of the '899 patent, which are directed to the preparation of membranes from hydrophobic polymers.

8. I have reviewed U.S. Patent No. 3,762,566 issued to Del Pico ("the '566 patent"). The '566 patent discloses cellulosic membranes in tubular form, not flat sheet form. Considerable differences exist in the methods employed to prepare tubular form and flat sheet form membranes, and these differences can have a substantial effect on pore morphology. In general, in casting tubular form membranes one needs a higher viscosity casting dope than is employed in casting flat sheet membranes. The viscosity of the casting dope can affect whether

the resulting membrane has macrovoids or is substantially free of macrovoids. Also, the casting conditions for tubular membranes are very different from those for flat membranes, since tubular form casting methods can employ an inner core quench solution and an outer core quench solution, whereas in casting flat sheet membranes, only one quench solution on a single side can be employed. The use of two quench solutions versus a single quench solution can also affect whether the resulting membrane has macrovoids or is substantially free of macrovoids. Another difference is that in casting tubular form membranes, one casts and extrudes the casting dope, with the extrusion draw ratio affecting whether the resulting membrane has macrovoids or is substantially free of macrovoids. In contrast, in casting a flat sheet membrane, there is no draw ratio effect. Accordingly, producing a flat sheet membrane that is substantially free of macrovoids, based upon the teachings of a method specifically designed for the preparation of tubular form membranes, would require a significant experimental undertaking. A person of ordinary skill in the art would not look to the '566 patent as an adequate guide for how to make a flat sheet cellulosic membrane without macrovoids, and would not reasonably expect to succeed in attempting to make such a membrane.

9. I declare that all statements made herein are true, and that all statements made upon information and belief are believed to be true, and further, that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that willful, false statements may jeopardize the validity of the application, or any patent issuing thereon.

Dated: 2/13/04

I-fan Wang

S:\DOCS\RMT\RMT-2808.DOC
010904